cyanide of potassium. The conclusion I formed was that for some reason or other, perhaps the greater salinity of the water, the conditions at Burnham were so adverse as to have developed a specially hardy race, which could withstand what easily killed those living under more favourable conditions. Nor is this all. When 16 years ago I first began to prepare and mount marine animals in balsam as lantern-slides, and took very little care, I mounted a specimen of *N. diversicolor* from the Queenborough district which shows no trace of decomposition anywhere, and the minute blood-vessels of the parapodia are most unusually well preserved, filled with red blood. I have since preserved or tried to preserve many specimens from the Orwell and the Colne estuary, and, even when using much care, I found that in drying it was very difficult to prevent decomposition setting in from one cause or another, and even in my most successful preparations the blood-vessels are well preserved only here and there. It thus seems that, even when dead, specimens from different localities may differ much in the power of resisting decomposition; animals of the same species thus varying in physiological and chemical characters. I may also say that the relative amount of hæmoglobin differs enormously, some being deep red and others quite pale.

On the Membranous Labyrinths of *Echinorhinus*, *Cestracion*, and *Rhina*.

By Charles Stewart, LL.D., F.R.S., F.L.S.

[Read 1st March, 1906.]

(Plate 44.)

Echinorhinus spinosus. Fam. Spinacidæ. (Pl. 44. fig. 1.)

The fish upon which this dissection was made was 227 cm. (7 ft. 6 in.) in length. The utricle showed the usual complete separation into anterior and posterior portions, between which lay the ductus endolymphaticus passing upwards directly to a point immediately beneath the skin, where it passed backwards and enlarged into a pigmented, somewhat rugose distensible chamber, 15 mm. in length and 4 mm. in breadth. From the posterior superior angle of this a minute continuation passed upwards and slightly backwards through the skin to the apertura externa. The anterior utricle and the recessus com-

municated by a common fissure-like opening with the sacculus. This fissure was 15 mm. in length, commencing in a point posteriorly and gradually widening to 3 mm. in front. It probably represented the canalis utriculi anterior, ductus utriculi, and canalis recessu-saccularis found in certain other Sharks, but, owing to its character, I shall speak of it as the fissura utriculo-saccularis.

The posterior utricle presented the usual characters and communicated by a round hole, about 2 mm. in diameter, with the saccule in front.

The saccule and lagena were both of large size and with the external face directed outwards and forwards.

The nerve-supply of the ampullæ was of the usual amount, that of the recessus moderate in quantity, the sacculus and lagena being very slightly supplied. The long nerve from which branches are given off to the saccule and lagena ran first of all upwards and then dipped downwards to supply the ampulla of the posterior canal, lying in the latter part of its course on the external surface of the utriculus posterior. Immediately before passing behind this structure it gave off the ramulus neglectus.

The sacculus and lagena were filled with a perfectly colourless and transparent mass of mucin of a firm jelly-like consistence, in which the otoconia (moderate in amount) were imbedded.

Immediately behind the small opening in the cartilaginous cranium, through which the ductus endolymphaticus passed, was an oval deficiency in the skull closed by tough fibrous membrane; it led directly into the large space in which the dorsal end of the posterior utricle and commencement of the posterior canal were lodged. It measured 17 mm. × 11 mm., its long axis being parallel with the posterior canal.

A similar opening has often been described in other Elasmobranchs, and is referred to in a paper by the late Prof. G. B. Howes in the Journal of Anat. & Physiol. vol. xvii. 1883, p. 188.

Cestracion philippi. Fam. Cestracionidæ. (Pl. 44. fig. 2.)

The specimen from which this labyrinth was obtained measured about 100 cm. (3 ft. 4 in.) in length.

In proportion to this size the labyrinth is small and the otoconia, if present, scanty. The chief peculiarity of the labyrinth lay in the ductus endolymphaticus. This passed through a long canal

in the cartilage, 4 mm. in breadth, to whose anterior wall it was firmly attached by the perichondrium. After passing through the skull, it made the usual bend forwards for about 5 mm. Here I believe it ended abruptly, as, though looked for carefully, the duct was not traced further nor was any external aperture found. The recessus only communicated directly with the utricle above.

The anterior utricle communicated with the saccule by a small opening (canalis utriculo-saccularis anterior). The posterior utricle had a similar small opening into the saccule (c. utric.-sacc. posterior).

The nerves to the ampullæ of the anterior and external canals were long, and those to all the ampullæ large. Nerves supplying the recessus, sacculus, and lagena were not found, and were probably of minute size.

The outer face of the saccule and lagena was directed outwards and forwards at an angle of 45° to the mesial plane.

Rhina squatina. Fam. Rhinidæ.

Although the membranous labyrinth of this somewhat Ray-like Shark has been figured and described by Retzius, yet I can nowhere find any account of a feature which is most remarkable and, so far as I am aware, unique in the Vertebrata—namely, a complete absence of otoconia, its place being taken by sand-grains introduced from without through the comparatively large external opening of the ductus endolymphaticus. The sand is often partly cemented into a thin plate that occupies the side of the saccular cavity next the macula, but elsewhere lies loose. This remarkable feature has been always found in the five or six specimens hitherto examined by me; but as it might be thought that otoconia had been got rid of through the same passage, I thought it well to examine a mature young before birth, which measured 190 mm. in length. The head was bisected, and all the tissues removed that surrounded the periotic capsule. This capsule with its contents was then divided, and the two halves of the saccule removed and examined under the microscope: no otoconia were found. As it might be thought that they were not present in other unborn Sharks, the unborn young of *Acanthias vulgaris* of similar length was examined; its saccule contained abundance of large crystalline otoconial particles.

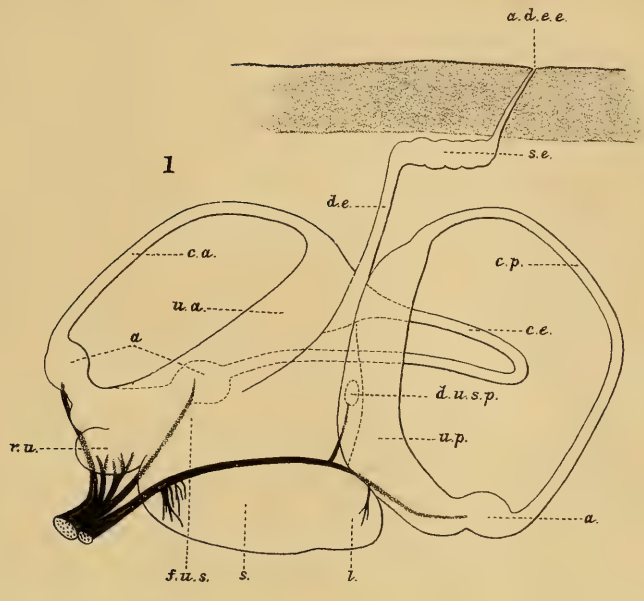
Although this replacement by foreign particles is probably peculiar to the genus *Rhina*, a mixture of otoconia and sand has been found by my friend Mr. R. H. Burne in specimens of *Acanthias vulgaris* about 2 feet in length, but in *Scyllium canicula* minute otoconia only were present. It should be noted in this regard that both *Acanthias* and *Rhina* are figured as having a similar ductus endolymphaticus of rather large size, that passes through the skin without diminishing and terminates in a large external aperture. In *Rhina* the apertura externa lies at the anterior border of a spineless, paler, and somewhat sunken patch of skin that in adult fish measured 5 mm. in diameter, those of opposite sides being 11 mm. apart. A saccus endolymphaticus (13 mm. in length) is well-defined from the rest of the duct and lies parallel to the skin. A firm round fibrous band arises from the skin shortly behind the apertura externa and is attached to the under surface of the saccus throughout its entire length, blending again with the skin immediately in front of it. It is common in Sharks for the cutaneous portion of the duct to be reduced to a tube of great fineness, with only a minute external opening.

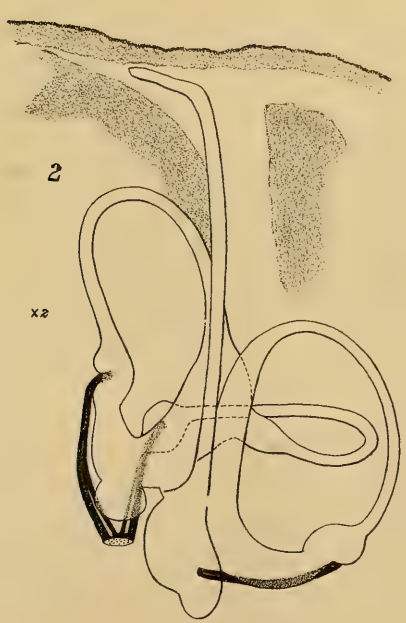
Of course it is well known that in most Decapod Crustacea sand is introduced into the auditory sac after each moult. Indeed, I have found the shells of Globigerinæ in the auditory sac of the Zoœa stage of a foreign Crab.

EXPLANATION OF PLATE 44.

Fig. 1. Right membranous labyrinth of *Echinorhinus spinosus*. Nat. size.
2. Right membranous labyrinth of *Cestracion philippi*. × 2.

a. Ampullæ.
a.d.e.e. Apertura ductus endolymphatici externa.
c.a. Canalis anterior.
c.p. Canalis posterior.
c.e. Canalis externus.
d.e. Ductus endolymphaticus.
d.u.s.p. Ductus utriculo-sacularis posterior.
f.u.s. Fissura utriculo-sacularis.
l. Lagena cochleæ.
r.n. Ramulus neglectus.
r.u. Recessus utriculi.
s. Sacculus.
s.e. Saccus endolymphaticus.
u.a. Utriculus anterior.
u.p. Utriculus posterior.





C. Stewart del.

M. P. Parker lith.
Parker & West imp.

MEMBRANOUS LABYRINTHS OF ECHINORHINUS AND CESTRACION.